embodiments may be utilized and structural changes may be made without departing from the scope of the present invention.

[0128] It is to be understood that in different embodiments of the invention, each battery in the Figures or the description can be implemented using one or more cells, and if a plurality of cells is implemented, the cells can be wired in parallel or in series. Thus, where a battery or more than one cell is shown or described, other embodiments use a single cell, and where a single cell is shown or described, other embodiments use a battery or more than one cell. Further, the references to relative terms such as top, bottom, upper, lower, etc. refer to an example orientation such as used in the Figures, and not necessarily an orientation used during fabrication or use.

[0129] The terms wafer and substrate as used herein include any structure having an exposed surface onto which a film or layer is deposited, for example, to form an integrated circuit (IC) structure or an energy-storage device. The term substrate is understood to include semiconductor wafers, plastic film, metal foil, and other structures on which an energy-storage device may be fabricated according to the teachings of the present disclosure. The term substrate is also used to refer to structures during processing that include other layers that have been fabricated thereupon. Both wafer and substrate include doped and undoped semiconductors, epitaxial semiconductor layers supported by a base semiconductor or insulator, as well as other semiconductor structures well known to one skilled in the art. Substrate is also used herein as describing any starting material that is useable with the fabrication method as described herein.

[0130] The term battery used herein refers to one example of an energy-storage device. A battery may be formed of a single cell or a plurality of cells connected in series or in parallel. A cell is a galvanic unit that converts chemical energy, e.g., ionic energy, to electrical energy. The cell typically includes two electrodes of dissimilar material isolated from each other by an electrolyte through which ions can move.

[0131] The term adatom as used herein refers to a particle, molecule, or ion of material that has not yet been formed into a structure or film.

[0132] The term intercalation as used herein refers to a property of a material that allows ions to readily move in and out of the material without the material changing its phase. Accordingly, a solid-state intercalation film remains in a solid state during discharging and charging of an energy-storage device.

[0133] **FIG.1B** shows an embodiment of an energy-storage device **50** according to the present invention. A substrate **55** is provided on which is formed a contact film **57**. Contact film **57** acts as a current collector and is connected to a lead **58**, which connects one pole of the energy storage device **50** to an external circuit. An electrode film **59** is formed on the contact film **57**. In some embodiments, the electrode film **59** substantially covers a surface of the contact film **57** to as to minimize resistance by maximizing the area of the interface between the films. In some embodiments, the electrode film **59** is a cathode for a thin-film battery. In other embodiments, electrode film **59** is an electrode of a supercapacitor. An electrolyte film **61** is formed on the electrode film **59**. An electrode film **63** is formed on the electrolyte film **61**. The electrolyte film **61** isolates electrode film **59** from electrode film **63**. A contact film **65** is formed on electrode film **63**. Contact film **65** acts as a current collector and is connected to a lead **67**, which connects one pole of the energy storage device **50** to an external circuit. In some embodiments, the contact film **65** substantially covers a surface of the electrode film **63** to as to minimize resistance by maximizing the area of the interface between these films. In some embodiments, the electrode film **63** is an anode for a thin-film battery. In other embodiments, electrode film **63** is an electrode of a supercapacitor.

[0134] **FIG. 1C** shows a cross sectional view of an embodiment of an energy-storage device **50**C. A substrate **55** is provided and, in some embodiments, includes additional layers and/or devices formed therewith. In some embodiments, the substrate **55** includes a substrate as described herein. Contact films **57** and **59** are formed on the substrate **55** according to the methods described herein. In some embodiments, contact films **57** and **59** are metal films deposited on the substrate according to other methods as known in the art. Contact films **57** and **59** act as contacts for connecting the energy-storage device **50**C to other circuit elements (not shown).

[0135] An electrode first film **59** is formed on contact **57**. Electrode first film **59** includes a metal or intercalation material in some embodiments, for example, thin-film battery embodiments in which the electrode first film **59** functions as a cathode. In some such embodiments, the electrode first film **59** includes lithium metal and/or a lithium-intercalation material. In other embodiments, such as supercapacitors, electrode first film **59** is a metal oxide. It is desirable to maximize the contact interface between the electrode first film **59** and contact film **57**. Accordingly, in some embodiments, the electrode first film **59** substantially covers contact film **57** except for a portion reserved for connection to external circuits.

[0136] An electrolyte film **61**C is formed on, or at least partially on, the electrode first film **59**. The electrolyte film **61**C, in some embodiments, completely encloses the electrode first film **59**. The electrolyte film **61**C is formed using the systems and methods described herein. In one embodiment, a first material of the electrolyte film **61**C is deposited using a first source, which directs a first electrolyte material (adatoms) to the location on the substrate or, as shown in **FIG. 1**C, to a location on the electrode first film **59**.

[0137] An electrode second film **59** is formed on electrolyte film **61**C and contact film **59**. Electrolyte film **61**C completely separates the electrode first film **59** from the electrode second film **59**. The electrode second film **63** includes a metal or intercalation material in some embodiments, for example, thin-film battery embodiments in which the electrode second film is an anode. In other embodiments, such as supercapacitor embodiments, electrode second film **63** is a metal oxide. Electrode second film **63**, in some embodiments is deposited according to the methods described herein. In other embodiments, electrode second film **63** is formed according to methods known in the art.

[0138] The electrolyte film **61**C as deposited includes the electrolyte material. A first source (e.g., sources **311**, **511**, **511**A, and **711** as described herein) of the electrolyte material, in one embodiment, is a physical vapor deposition